(12) PATENT ABSTRACT

(19) AU (11) AU-A1-70 604/81

(54) VANADIUM FROM IRON ORE

(71) MANNESMANN AG

(21) 70 604/81 (22) 15.5.81 (24) 16.5.80

(31) 3018689 (32) 16.5.80 (33) DE

(43) 19.11.81.

(51)[3] C22B 34/22 C22B 7/04

(72) Driemeyer, W.

(74) DC

(57) Claim

1. A method of obtaining vanadium during the production of steel from sponge iron obtained by direct reduction of vanadium-containg ore, wherein the sponge iron is processed directly into steel which is vanadium-free or has only a small vanadium content, the steel and the associated primary slag which has a vanadium content are tapped separately and the slag is subsequently reduced in a reduction furnace, crude iron being formed by the reduction of iron oxide in the slag absorbing the vanadium also reduced from the slag; wherein during the reduction of the vanadium-containing primary slag, there is added an additional quantity of crude iron which is vanadium-free or has only a small vanadium content, wherein the vanadium is extracted and the vanadium-containing crude iron is subsequently oxidised selectively by the shaking ladle method known per se, and a vanadium-containing secondary slag formed.

Form 10

COMMONWEALTH of AUSTRALIA

PATENTS ACT 1952-1962

COMPLETE SPECIFICATION

(Original)

FOR OFFICE USE: 70604/81

Class Int. Class

Application Number:
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority:

Related Art:

Name of Applicant:

MANNESMANN AKTIENGESELLSCHAFT

Address of Applicant:

Mannesmannufer 2,
D-4000 Dusseldorf, GERMANY

Actual Inventor(s):

MANFRED DRIEMEYER

Address for Service: DAVIES & COLLISON, Patent Attorneys,
A.M.P. Building, Hobart Place, Canberra, A.C.T. 2601.

Complete Specification for the invention entitled:

"IMPROVEMENTS IN RECOVERING VANADIUM FROM IRON ORES"

The following statement is a full description of this invention, including the best method of performing it known to :-

This invention relates to a method of recovering vanadium during the production of steel from sponge iron.

It is already known for the vanadium present in some iron ores to be extracted as a by-product during iron and steel making. In the known "Highveld-method", the iron ore previously reduced in a direct reduction unit is processed in an electro-reduction furnace into crude iron. In this process, the majority of the vanadium is absorbed by the crude iron which is subsequently subjected to a selective oxidation process in a shaking ladle and a vanadium oxide-containing secondary slag is formed. The vanadium yield as well as the vanadium concentration in the secondary slag cannot be controlled in this method, but automatically adjusts itself.

Another known method of steel production starting from sponge iron makes use of the electroslag heating

furnace, see the specification of Australian Patent application No. 51544/79 the disclosure of which is incorporated herein. The starting material is pre-reduced in a direct reduction unit.

When using the electroslag heating furnace, the proportions occurring with respect to the vanadium behaviour are quite different from those in the Highveld-method. Whereas in the Highveld-method, the resulting slag is almost iron-free and the vanadium is absorbed by the metal; in the case of smelting in the electroslag heating furnace, steel is produced in the first stage of the method and the vanadium is absorbed almost completely by the primary slag, owing to its high FeO content.

The primary slag having a vanadium content tapped from the electroslag heating furnace is supplied after the tapping operation to a reduction furnace in the second stage of the method. There, FeO is also partially reduced simultaneously from the slag during melting of the slag and during reduction with carbon carriers, for example, coal, and a small quantity of crude iron is formed which absorbs the vanadium also reduced. As this quantity of crude iron is very small, only a small proportion of the vanadium present passes into the metal whereas the majority remains in the secondary or final slag remaining after this operation.

In the normal operating range, a maximum vanadium yield of from 15 to 20% is obtained, for example, from

the primary slag containing 20% of FeO. This small yield is due to the fact that insufficient quantities of crude iron are produced during the reduction process.

An object of the present invention is to provide a method of obtaining vanadium from iron ore containing the same, which does not suffer from the above-mentioned disadvantages and, in particular, permits maximum quantities of vanadium to be absorbed by the crude iron. Accordingly, the invention provides a method of recovering vanadium during the production of steel from sponge iron obtained by the direct reduction of vanadium-containing ore , wherein the sponge iron is reduced into steel and a primary slag formed, the steel being substantially vanadium-free and the primary slag having a vanadium content; crude iron is added to the slag to supplement crude iron formed during a subsequent reduction of the primary slag, whereby the crude iron absorbs vanadium and is thereafter oxidised to form a vanadium-containing secondary slag. Advantageously, the electroslag heating method is used to reduce the sponge iron into steel. The vanadium-containing crude iron is preferably oxidised selectively by the shaking ladle principle already known. The vanadium is extracted from the secondary slag in a known manner. The quantity of vanadium-absorbing crude iron is increased in the second, or reduction stage of the method in accordance with the invention compared with the method described in the above-mentioned

specification so that a larger quantity of the vanadium present can be extracted.

The vanadium yield and vanadium concentration in the secondary slag can be controlled. By adding larger quantities of crude iron, a higher vanadium yield is achieved despite a relatively low vanadium concentration in the secondary slag. If relatively high vanadium concentrations in the secondary slag are desired with lower vanadium yields, correspondingly smaller quantities of crude iron need to be added.

The additional quantity of crude iron to be added is advantageously obtained from the quantity of crude iron resulting from the material processed in the shaking ladle during an earlier cycle of operation.

The vanadium yield and vanadium concentration in the secondary slag may be adjusted, in dependence upon the quantity of crude iron added. With large additions of crude iron, a high vanadium yield is achieved with a relatively low vanadium concentration in the secondary slag, whereas with smaller additions of crude iron, correspondingly smaller vanadium yields are adjusted with relatively higher vanadium concentrations in the secondary slag.

The ratio by weight of the additional quantity of crude iron to the weight of sponge iron used can be, for example, 1:1 if very high vanadium yields are to be achieved.

The vanadium yield is defined as follows:

a) for continuous and dot-dash (Highveld-method) lines: kilogram of vanadium in the crude iron (after selective reduction of the primary slag) per kilogram of vanadium in the primary slag,

b) for broken lines and for lines representing the method in accordance with the invention: kilogram of vanadium in the crude iron (after selective reduction of the primary slag) per kilogram of vanadium in the pre-reduced ore.

The FeO content of the primary slag is used as a parameter.

A marked dependency on the FeO content of the secondary slag as well as on the FeO content of the primary slag can be determined from the continuous and broken lines (without addition of crude iron).

A high vanadium yield could only be expected with extremely low FeO contents in the secondary slag (0.2%), not possible in practice, and with high FeO contents in the primary slag (20%). However, the normal operating range lies between 1 and 1.5% of FeO in the secondary slag. The vanadium yield is relatively low in this given operating range.

As shown by the uppermost curves representing the method in accordance with the invention (top right hand corner in the graph), the yield is even higher than in the Highveld-method. The quantity of crude iron is in fact only increased by addition of vanadium-free crude

iron in such a way that substantially larger absolute quantities of vanadium are absorbed by the crude iron.

In the method in accordance with the invention, there is only a slight, insignificant dependency on the FeO content of the primary slag. It is obvious that the influence of the FeO contents of the initial slag is masked by the additions of crude iron.

Yields of about 90% are feasible by the method in accordance with the invention.

The invention may be carried into effect using the apparatus described and illustrated in the above-mentioned specification, reference to which should be made. The method of operation therein disclosed is modified by taking a quantity of the crude iron 20 tapped from the shaking or oscillatory ladle 17 during a previous cycle of operation, and introducing this quantity of molten metal into the furnace 9 before or during the reduction of slag therein in the course of a subsequent cycle of operations. Since the vanadium has concentrated itself in the secondary slag produced during the reducing operation in the ladle 17, the crude iron 20 is substantially vanadium-free. This quantity of iron, when added to the furnace 9, supplements the crude iron and enhances vanadium extraction as described above.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A method of obtaining vanadium during the production of steel from sponge iron obtained by direct reduction of vanadium-containg ore, wherein the sponge iron is processed directly into steel which is vanadium-free or has only a small vanadium content, the steel and the associated primary slag which has a vanadium content are tapped separately and the slag is subsequently reduced in a reduction furnace, crude iron being formed by the reduction of iron oxide in the slag absorbing the vanadium also reduced from the slag; wherein during the reduction of the vanadium-containing primary slag, there is added an additional quantity of crude iron which is vanadium-free or has only a small vanadium content, wherein the vanadium is extracted and the vanadium-containing crude iron is subsequently oxidised selectively by the shaking ladle method known per se, and a vanadium-containing secondary slag formed.

2. A method according to Claim 1, wherein the quantity of crude iron so added is obtained from the crude iron formed by the shaking ladle method, which is vanadium-free or has only a small vanadium content.

3. A method according to Claim 1 or Claim 2, wherein a desired vanadium yield and vanadium concentration may be adjusted in the vanadium-containing final slag.

4. A method according to any preceding claim, wherein the sponge iron is processed into steel by the electroslag heating method.

5. A method as claimed in Claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

6. A method of recovering vanadium during the production of steel from sponge iron obtained by the direct reduction of vanadium-containing ore, wherein the sponge iron is reduced into steel and a primary slag formed, the steel being substantially vanadium-free and the primary slag having a vanadium content; crude iron is added to the slag to supplement crude iron formed during the reduction of the primary slag, whereby the crude iron absorbs vanadium and is thereafter processed to form a vanadium-containing secondary slag from which the vanadium is extracted.

7. The parts, elements, steps and features referred to or indicated in the specification and/or claims and/or drawings of this application, individually or collectively, and any and all combinations of any two or more of said parts, elements, steps or features.

DATED this fifteenth day of May, 1981
MANNESMANN AKTIENGESELLSCHAFT
By its Patent Attorneys
DAVIES & COLLISON

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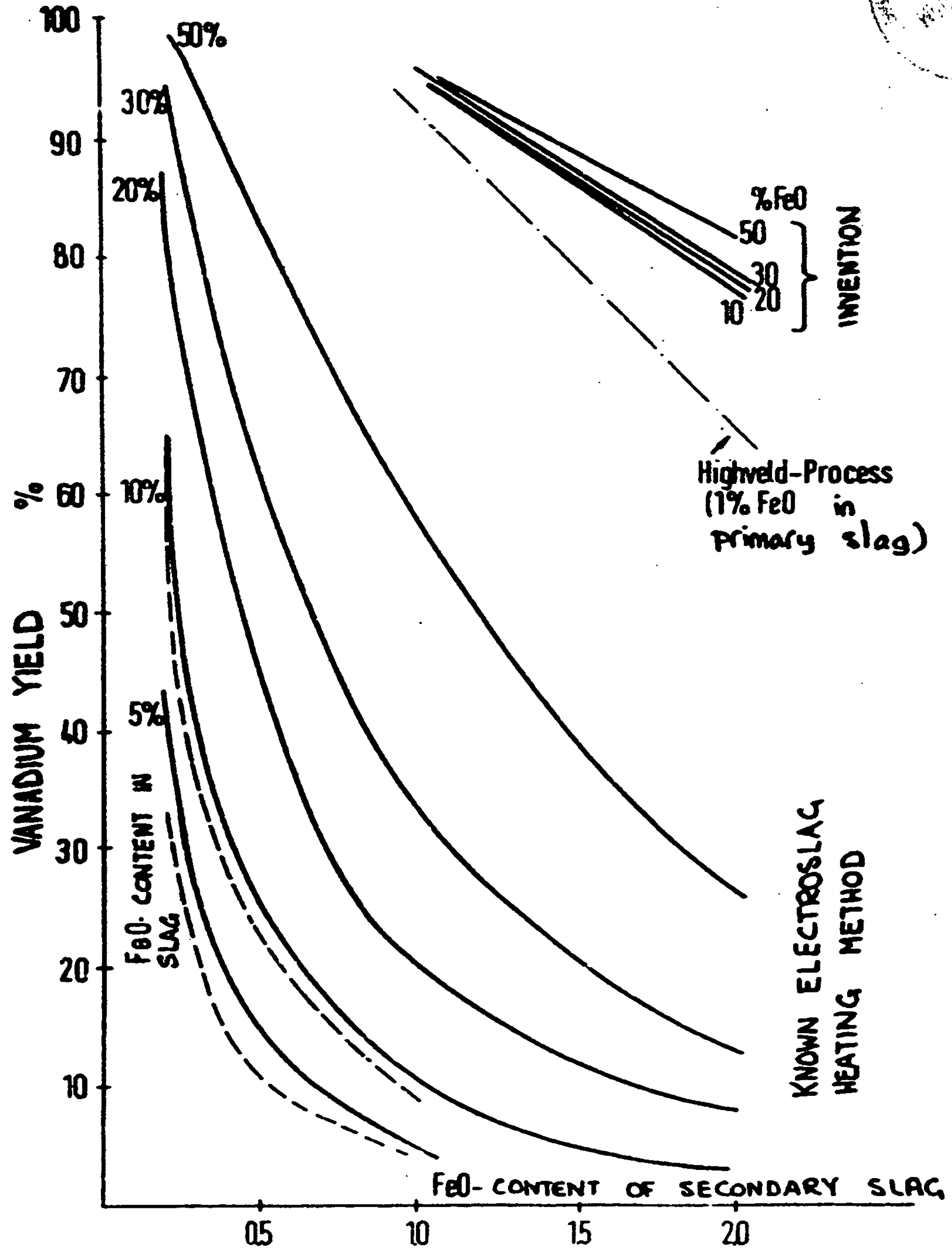

100
90
80
70
60
50
40
30
20
10
%
VANADIUM YIELD
50%
30%
20%
10%
5%
FeO- CONTENT IN SLAG
%FeO
50
30
20
10
INVENTION
Highveld-Process (1% FeO in primary slag)
KNOWN ELECTROSLAG HEATING METHOD
FeO- CONTENT OF SECONDARY SLAG
0.5
1.0
1.5
2.0